

# PHYSIOLOGICAL MODIFICATIONS IN *PRUNUS AVIUM* L. AS A RESULT OF THE ATTACK PRODUCED BY *STIGMINA CARPOPHILA* (LÉV.) M.B.ELLIS

NICOLAE I.<sup>1</sup>, BUȘE-DRAGOMIR LUMINIȚA<sup>1\*</sup>

<sup>1</sup> University of Craiova

\*Corresponding author. Email: [luminita25dragomir@yahoo.com](mailto:luminita25dragomir@yahoo.com)

**Keywords:** attacked leaves, healthy leaves, pathogen, photosynthesis, transpiration.

## ABSTRACT

The research regarding physiological modifications produced by *Stigmina carpophila* (Lév.) M.B.Ellis was performed in *Prunus avium* L. cultivated in the climatic conditions in Oltenia region.

In the leaves of the *Prunus avium* L. attacked by *Stigmina carpophila* (Lév.) M.B.Ellis observed that the photosynthesis and transpiration intensity is similar to that in healthy leaves, but the recorded values are lower as a result of the reduction of the assimilation surface due to the formation of spots and necrosis on the leaves. The water content has lower values in the leaves of plants attacked by the pathogen, fact highlighted by the withering and drying of the leaves and the chlorophyll content also has lower values, which is correlated with the intensity of photosynthesis.

## INTRODUCTION

Sweet cherry (*Prunus avium* L.) and sour cherry (*Prunus cerasus* L.) production is threatened by a significant number of phytopathogens affecting cherry leaves and causing premature defoliation, reduced shoot growth, increased susceptibility to winter injury, higher tree mortality, branch breakage and replanting problems (Iličić et al., 2019).

Leaf infection leading to defoliation in the most serious aspect of shot hole diseases, because severe defoliation during early fruit development can cause the young fruits to fall, and repeated defoliation weakens the trees and reduces their yield (Teviotdale et al., 1999).

Disease development is mostly governed by certain weather parameters, such as temperature fluctuations, as well as averages of maximum and minimum temperatures, relative humidity and average of rainfall. If control measures are, inadequate and conditions for leaf disease development favorable, infection will occur at much higher intensity,

resulting in premature defoliation inadequate and conditions for leaf disease development favorable, infection will occur at much higher intensity, resulting in premature defoliation (Iličić et al., 2019).

The net photosynthetic activity is subjected to seasonal changes and to diurnal changes which are mainly influenced by the stage of shoot development, the leaf ageing, the accumulation of hormones and of carbohydrates in the leaves, as well as the by the fluctuations of light, leaf temperature, air temperature and humidity (Lakso, 1985). The research regarding photosynthesis intensity in *Cerasus avium* shows values of 10.2 - 11.7  $\mu\text{mol CO}_2/\text{m}^2/\text{s}$  (Gucci et al., 1990).

Photosynthetic active radiation intensity is a limiting factor in the process of photosynthesis. Reception of photosynthetic active radiation by tree leaves and bushes is dependent on height, distance of planting, position of the crown shape (Burzo et al., 1999).

The increase of the photosynthetic active radiations, leaf temperature and stomatal conductance is positively correlated with the increase of the photosynthesis and of the transpiration, but shows variations in the attacked leaves as a result of several structural modifications produced by the pathogen (Nicolae and Camen, 2011).

## MATERIAL AND METHOD

The research on the physiological changes produced by *Stigmina carpophila* (Lév.) M.B.Ellis was made in 2019, in *Prunus avium* L. species, cultivated in the Oltenia region.

*Prunus avium* L. is an oval-crowned tree with long branches, the leaves are alternate, bright green, simple ovoid-acute with serrated edge. The flowers are produced in early spring, they are hermaphroditic, borne in corymbs and the fruit is a drupe, bright red to dark purple, variably sweet to somewhat astringent.

The estimation of the attack was made using the calculation formulae elaborate by Săvescu and Rafailă (Săvescu and Rafailă, 1978).

The intensity of the photosynthesis and transpiration was established with the analyzer LCI which enables automatic recording and other parameters (photosynthetic active radiations, leaf temperature, stomatal conductance etc.).

The water contents and the dry substance content were determined by the help of the gravimetric method. The chlorophyll content were estimated with the Minolta SPAD 502 chlorophyllmeter.

## RESULTS AND DISCUSSIONS

Shot hole blight or shot hole disease is a fungal disease of stone fruit trees including peach, nectarine, apricot, plum, cherry and almond. The most commonly affected are apricot, peach and nectarine, and to lesser degree cherries (Ivanová et al., 2012).

*Stigmina carpophila* Lév.) M.B. Ellis (syn. *Wilsonomyces carpophilus* (Lév.) Adask., J.M. Ogawa & E.E. Butler) can infect buds, branches, blossoms, leaves and fruits. The attacked leaves show small brown spots with reddish margins, these spots expand as circular lesions (2-3mm). Over time, the tissue near the spots necrosis and falls off, so that the leaves appear perforated (Fig. 1).

The attacked twigs show clear-cut brown margins with a necrotic center. The attacked fruits present small circular, deep purple spots and as the disease progresses while in severe cases present cracks in the skin. The pathogen infect the leaves, stems and fruits during cold, rainy weather periods in spring and autumn.

*Stigmina carpophila* (Lév.) M.B. Ellis presents mycelium in the form of cylindrical, septate, yellow-brown filaments (Fig. 2).

Conidiophores and conidia formed, tear the epidermis and come to the surface. Conidiophores are simple, filamentous, septa, hyaline or yellow-brown, at the end of which a single conidia is formed, oval-cylindrical, at first hyaline and unsept, then yellow-brown with 2-6 transverse walls.

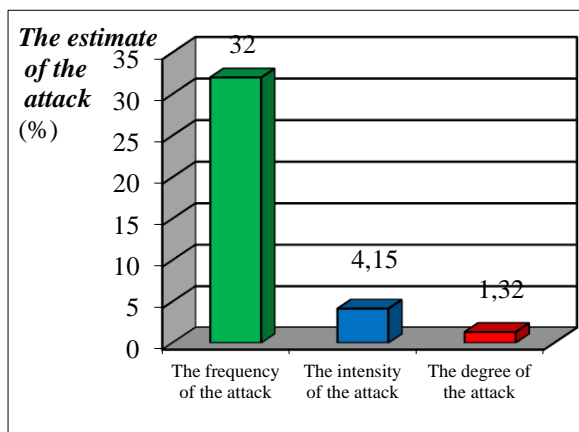


**Fig. 1. The *Prunus avium* L. attacked by *Stigmina carpophila* (Lév.) M.B.Ellis -the upper face of the attacked leaves (Original).**



**Fig. 2. *Stigmata carpophila* (Lév.) M.B.Ellis-conidia(oc. 10 x ob. 20) - Original.**

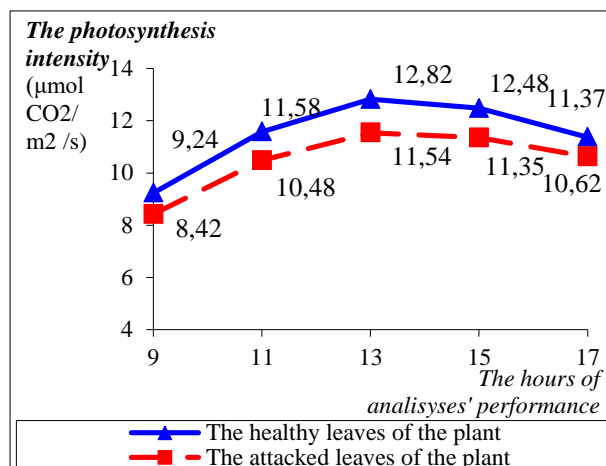
The estimation of the attack (the frequency, the intensity and the degree of the attack) produced by *Stigmata carpophila* (Lév.) M.B.Ellis in *Prunus avium* L. is presented in Fig. 3.



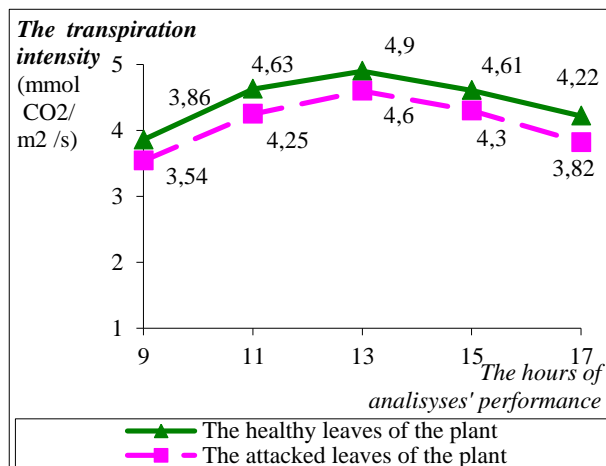
**Fig. 3. The estimate of the attack produced by *Stigmata carpophila* (Lév.) M.B.Ellis at the *Prunus avium* L.**

The research regarding physiological modifications produced by the pathogen was performed in *Prunus avium* L. was performed according to the climatic conditions on May 27<sup>th</sup> 2019.

The photosynthesis and transpiration intensity in the attacked leaves shows lower values as a result of the reduction of the assimilation surface due to necrosis of the spots on the leaves, the deterioration of the chlorophyll, but also by malfunctioning of stomata closing and opening mechanisms (Fig. 4 and Fig. 5).



**Fig. 4. The diurnal dynamics of photosynthesis in the leaves of the *Prunus avium* L.**



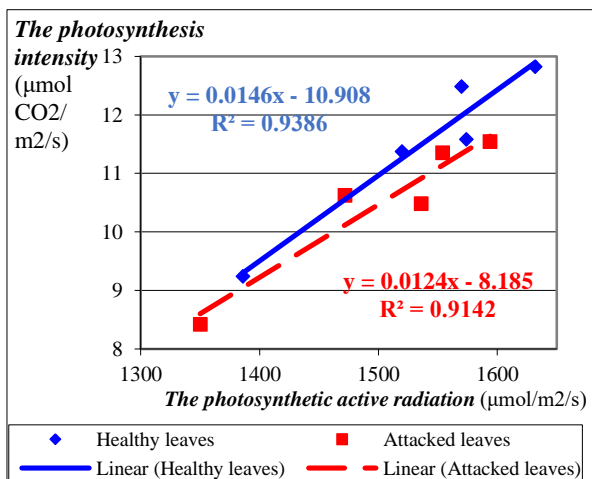
**Fig. 5. The diurnal dynamics of transpiration in the leaves of the *Prunus avium* L.**

In the analyzed *Prunus avium* L. was established a strong association between the physiological processes and photosynthetic active radiations, leaf temperature and stomatal conductance.

The photosynthesis and transpiration intensity depend on the light

radiation received by leaves, which are dependent on the position of the leaves on plants. The increase in photosynthetic active radiations was observed in the morning (9 a.m.), when one can record values of  $1386 \mu\text{mol} / \text{m}^2 / \text{s}$  for the healthy leaves and of  $1350 \mu\text{mol} / \text{m}^2 / \text{s}$  for the attacked leaves, values which increase until afternoon (1 p.m.) when one record  $1632 \mu\text{mol} / \text{m}^2 / \text{s}$  for the healthy leaves and  $1594 \mu\text{mol} / \text{m}^2 / \text{s}$  for the attacked leaves, and then towards evening (5 p.m.) a gradual decrease is noticed, recording values of  $1520 \mu\text{mol} / \text{m}^2 / \text{s}$  for the healthy leaves and of  $1472 \mu\text{mol} / \text{m}^2 / \text{s}$  for the attacked leaves.

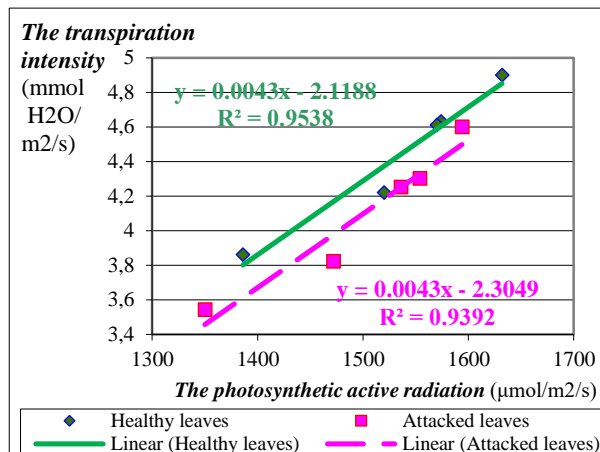
Linear regression shows a positive correlation between the photosynthesis intensity and photosynthetic active radiations were the coefficient of determination  $R^2$  was 0.93 for the healthy leaves and 0.91 for the attacked leaves and between the transpiration intensity and photosynthetic active radiations were the coefficient of determination  $R^2$  was 0.95 for the healthy leaves and 0.93 for the attacked leaves (Fig. 6 and Fig. 7).



**Fig. 6. The correlation between the intensity of photosynthesis and the photosynthetic active radiation in the leaves of the *Prunus avium* L.**

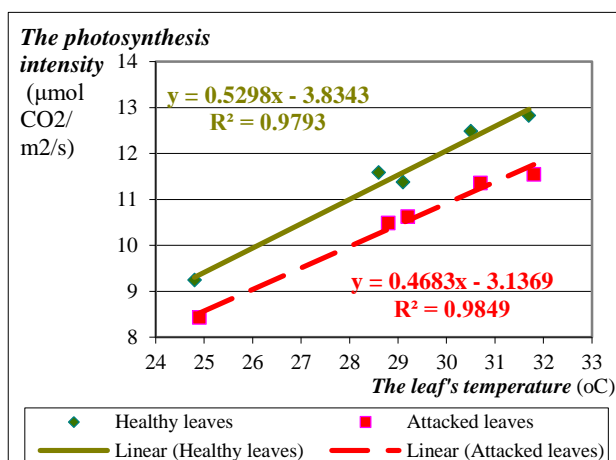
The leaf temperature during the day increase starting in the morning (9 a.m.) when value recorded is  $24.8^\circ\text{C}$  in the healthy leaves and  $24.9^\circ\text{C}$  in the

attacked leaves, increase until afternoon (1 p.m.) when value recorded is  $31.7^\circ\text{C}$  in the healthy leaves and  $31.8^\circ\text{C}$  in the attacked leaves and the evening (5 p.m.) temperature decrease when value recorded is  $29.1^\circ\text{C}$  in the healthy leaves and  $29.2^\circ\text{C}$  in the attacked leaves.



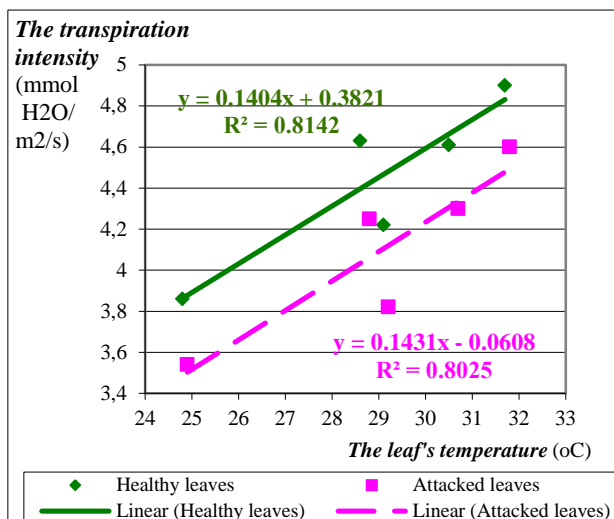
**Fig.7. The correlation between the intensity of transpiration and the photosynthetic active radiation in the leaves of the *Prunus avium* L.**

Linear regression shows a positive correlation between the photosynthesis intensity and of the leaf temperature (the coefficient of determination  $R^2$  was 0.97 for the healthy leaves and 0.98 for the attacked leaves) and between the transpiration intensity and of the leaf temperature ( $R^2$  was 0.81 for the healthy leaves and 0.80 for the attacked leaves) - Fig. 8 and Fig. 9.

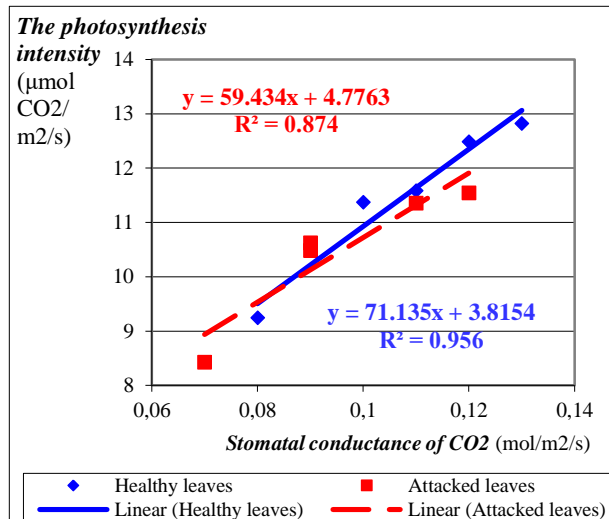


**Fig. 8. The correlation between the intensity of photosynthesis and the leaf temperature in the leaves of the *Prunus avium* L.**





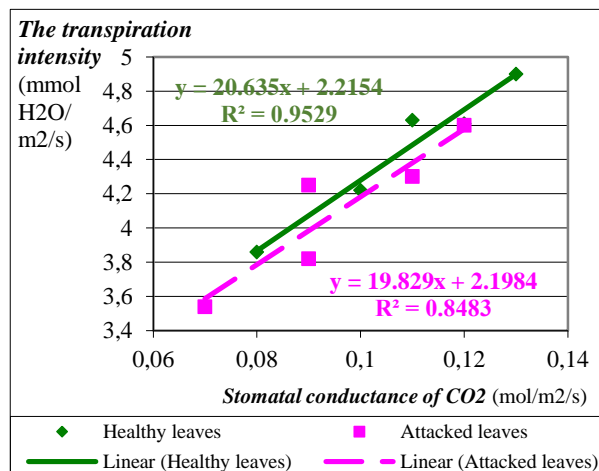
**Fig. 9. The correlation between the intensity of transpiration and the leaf temperature in the leaves of the *Prunus avium* L.**



**Fig. 10. The correlation between the intensity of photosynthesis and the conductance stomatal in the leaves of the *Prunus avium* L.**

The stomatal conductance increases until afternoon and then decreases as a result of the high temperature and low relative humidity of the air. In the morning (9 a.m.) one can observe an increase of the stomatal conductance, when the record values are 0.08 mol / m<sup>2</sup> / s in the healthy leaves and 0.07 mol / m<sup>2</sup> / s in the attacked leaves, the increase of the stomatal conductance until afternoon (1 p.m.) when the record values are 0.13 mol / m<sup>2</sup> / s in the healthy leaves and 0.12 mol / m<sup>2</sup> / s in the attacked leaves and towards the evening (5 p.m.) the gradual decrease of the stomatal conductance when the record values are 0.1 mol / m<sup>2</sup> / s in the healthy leaves and 0.09 mol / m<sup>2</sup> / s in the attacked leaves.

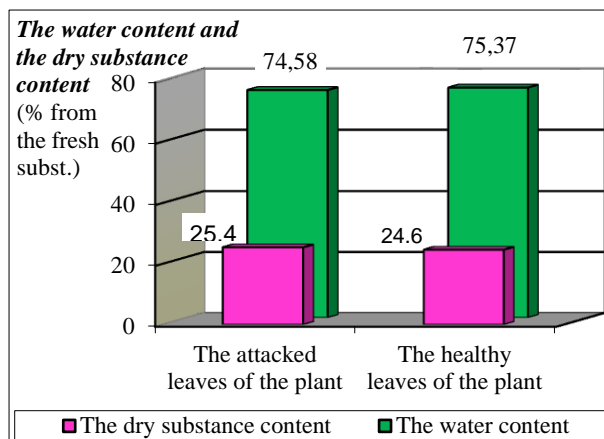
Linear regression performed shows a positive correlation between the photosynthesis intensity and of the stomatal conductance were the coefficient of determination  $R^2$  was 0.95 for the healthy leaves and 0.87 for the attacked leaves and between the transpiration intensity and of the stomatal conductance were the coefficient of determination  $R^2$  was 0.95 for the healthy leaves and 0.84 for the attacked leaves (Fig. 10 and Fig. 11).



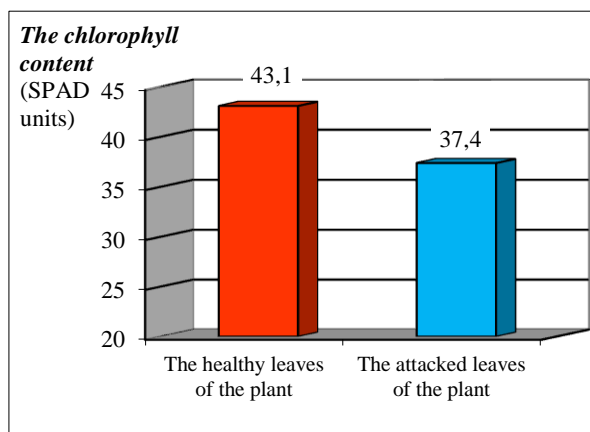
**Fig. 11. The correlation between the intensity of transpiration and the conductance stomatal in the leaves of the *Prunus avium* L.**

The attacked leaves by the pathogen present a lower water content fact manifested by the withering and premature drying of the leaves and the higher of dry substance content, in comparison with healthy leaves of plant (Fig. 12).

The attacked leaves present a lower chlorophyll content as a result of the blockage of its biosynthesis and the deterioration of the chlorophyll (Fig. 13).



**Fig. 12. The water content and the dry substance content in the leaves of *Prunus avium* L.**



**Fig. 13. The chlorophyll content in the leaves of the *Prunus avium* L.**

## CONCLUSIONS

The intensity of the physiological processes in *Prunus avium* L. varies according to the degree of attack, but also by the climatic conditions. At the attacked leaves one can observe that the intensity of the photosynthesis and the transpiration presents lower values in comparison with healthy leaves.

The increase of the photosynthesis and the transpiration intensity is positively correlate with the increase of the photosynthetic active radiations, temperature leaf and conductance stomatal, but shows variations in the attacked leaves, in comparison healthy leaves, as a result of several structural modifications produced by pathogen.

As a result of the action produced by the pathogen on the attacked leaves one can observe a decrease of the chlorophyll content because of the deterioration of the chlorophyll and the decrease of the water content, which determines the withering and the early drying of the leaves.

## BIBLIOGRAPHY

1. Burzo I., Toma S., Olteanu I., Dejeu L., Delian Elena, Hoza D., 1999 - *Fiziologia plantelor de cultură*, Întreprinderea Edit. Poligrafică Știința, Chișinău, 3: 440.
2. Gucci R., Grappadelli L. C., Neri D., Piccotino D., 1990 - *Field measurement of photosynthesis*. 3. *Net leaf photosynthetic rate and response curves of tree fruit crops to environmental factors*, Rivista di Frutticoltura e di Ortofloricoltura, 52 (8-9): 75-78.
3. Ilić Renata, Popović Tatjana, Vlajić S., Ognjanov V., 2019 - *Foliar pathogens of sweet and sour cherry in Serbia*, Acta Agriculturae Serbica, XXIV, 48:107-118.
4. Ivanová Helena, Kaločaiová Monika, Bolvanský M., 2012 - *Shot-hole disease on Prunus persica - the morphology and biology of Stigmata carpophila*, Folia oecologica, 39(1): 21-27.
5. Lakso A. N., 1985 - *The effects of water stress potential on physiological processes in fruit crops*, Acta Horticulturae, 171: 275-290.
6. Nicolae I., Camen D., 2011 - *Physiological modifications in Cerasus avium (L.) Moench as a result of the attack produced by Blumeriella jaapii (REHM) ARX*, Journal of Horticulture. Forestry and Biotechnology, Romania. 15(1): 107-112.
7. Săvescu A., Rafailă C., 1978 - *Proгноза în protecția plantelor*, Editura Ceres, București: 103.
8. Teviotdale B.L., Goodell, N., Harper, D., 1999 - *Shot hole encourages almond drop, doesn't harm kernels*, California Agriculture, 53: 16-18.